# Residential Density

This EnviroAtlas Smart Location map estimates residential density or housing units per acre within each U.S. Census block group. Block group acreage excludes parks, water bodies, conservation easements, and other area protected from development. However, transportation infrastructure and other land uses not associated with residential or commercial development are not removed.


Photo: Philadelphia residential area.

## Why is residential density important?

Residential Density is one of many measures or variables used by city planners to examine the proportions of residents, jobs, and services in urban areas and to guide development planning. Density ranges are used by local governments to justify transit investment and to promote development in areas within ½ mile of existing and potential transit stations to ensure maximum transit use.[1]

Compact neighborhoods, with a mix of residences, employment opportunities, and services, can offer a number of environmental benefits when compared to lower density neighborhoods. In more compact areas, people can travel shorter distances for everyday activities, and they may find it easier to walk or bike to those destinations. While residential density is not the only built-environment characteristic that affects travel behavior, research studies indicate that people who live in compact neighborhoods walk more, use transit more, and drive less than people living in lower density neighborhoods.[1,5] A minimal level of residential and employment density is necessary to support community design strategies that make alternatives to driving more viable. At least seven homes per acre are generally considered necessary to support basic fixed-route bus service. Higher density thresholds are recommended for supporting light rail or rapid transit lines.[2]

Compact development can also offer water quality benefits when compared to lower density development. Compact neighborhoods require less total land for development than lower density neighborhoods, resulting in a reduced area of paved and impervious surfaces. A study to evaluate pollutant loadings in stormwater runoff under a broad range of residential densities showed that as the number of homes per acre increased, so did the total amount of stormwater runoff and the total pollutant loadings of nitrogen, phosphorus, and suspended solids per acre. However, homes developed at a density of eight or more per acre produced less stormwater runoff and pollutant load *per housing unit* than homes developed at a typical suburban density of three to five homes per acre. In other words, for a constant number of households, denser development generated less total stormwater runoff per household.[3] An EPA study at the watershed level showed that increased housing density not only produced less runoff and impervious cover per household but it affected a much smaller area of the watershed than low-density development. With compact development, open land remained in the watershed for other uses, such as other types of development or conservation of ecologically sensitive sites.[4]

Higher housing densities combined with land use diversity that mixes housing, jobs, and services within neighborhoods can reduce vehicle miles traveled by making walking, biking, and transit more appealing. The National Research Council noted that doubling residential density in a metropolitan area with compact neighborhood design could reduce vehicle miles traveled by 5–12%.[5] Other recent studies suggest that consistently reducing private auto usage through urban development design guidelines nationwide could reduce vehicle emissions by 6-10% and improve regional air quality and public health through lower greenhouse gas emissions.[6]

## How can I use this information?

Evaluating residential density within an area of study can be useful in a number of different urban planning contexts. For instance, a transit planner may wish to identify neighborhoods and corridors that can support new or

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enhanced transit service. Localities may also consider residential density when prioritizing neighborhood improvements such as sidewalks, street lighting, or bike lanes. Focusing improvements in compact neighborhoods can ensure that the greatest number of people benefit.

This data layer may be used with other EnviroAtlas demographic and Smart Location data layers to compare the proportions of residents, jobs, and services among community block groups. The aerial-image base map (seen by increasing the transparency of the map layers) can be used to show the spatial distribution of the built environment within the census block groups. For select communities, users can overlay EnviroAtlas community land cover maps that show impervious surfaces, street trees, and other common land covers at 1-meter resolution.

## How were the data for this map created?

The 2010 Census provided a count of homes per census block group. Rather than calculate density over the entire land area of the block group, EPA isolated just the areas of the block group that were not protected from development. NAVTEQ data (2011) provided the location of federal, state, and local parks, zoos, cemeteries, public beaches, and water bodies. The Protected Area Database (PAD-US v1.3) provided the locations of parks and protected natural areas as well as privately-owned land area with restrictions on development (such as conservation easements). The relevant portions of each protected area dataset were intersected and dissolved into a single polygon layer that represented all areas in which development is restricted, either due to physical or institutional constraints. The resulting protected areas layer was then integrated with the block group areas in GIS to provide the total unprotected acreage for each block group. EPA used this block group unprotected acreage as the denominator to calculate metric D1a, residential density, or housing units per acre.

## What are the limitations of these data?

Some census block groups include both developed and undeveloped areas. Summarizing and estimating residential density across such block groups may create misleading results. This indicator is most useful for drawing attention to regional patterns or specific neighborhoods that would benefit from further study. Using the aerial-image base map will give an indication of the proportions of developed and undeveloped land in each census block group.

## How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. This data layer is incorporated into a larger EPA data product called the Smart Location Database. The Smart Location Database is a nationwide geographic data resource for measuring location efficiency. Most attributes are available for every census block group in the United States.

## Where can I get more information?

A selection of resources on the relationships among city planning, development densities, and environmental quality is listed below. Smart Growth Program provides tools, resources, and technical assistance to communities seeking to pursue compact and mixed-use development strategies to create vibrant, walkable neighborhoods while protecting public health and the environment. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

## Acknowledgments

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## Selected Publications

1. Florida Department of Transportation. 2009. Transit-oriented development design guidelines. Accessed July 2014.

2. Cervero, R., and E. Guerra. 2011. Urban densities and transit: A multi-dimensional perspective. Working Paper UCB-ITS-VWP-2011-6, Institute of Transportation Studies, University of California, Berkeley.

3. Jacob, J.S., and R. Lopez. 2009. Is denser greener? An evaluation of higher density development as an urban stormwater-quality best management practice. *Journal of the American Water Resources Association* 40:687–701.

4. Richards, L. 2006. Protecting water resources with higher-density development. EPA231-R-06-001. Office of Sustainable Communities, Environmental Protection Agency, Washington, D.C. 45 p.

5. National Research Council. 2009. Driving and the built environment: The effects of compact development on motorized travel, energy use, and $CO_2$ emissions. Special Report 298, The National Academies Press, Washington, D.C. 240 p.

6. Kramer, M. 2013. Our built and natural environments: A technical review of the interactions among land use, transportation, and environmental quality, Second edition. Environmental Protection Agency, Washington, D.C.